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Role of Microbes in Reclamation of Problem Soils

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Abstract

Soil reclamation is usually labor and cost intensive and thus in many cases uneconomical. The less expensive way to restore the quality of the ecosystem is to utilize microbes in so-called bioremediation. There are various ways in which flora can improve the soil ranging from trapping the pollutants in the rhizosphere, extracting them to upper parts of the plant or removing the volatile compounds through evaporation. The plants also impact the microbial community and help in recreating the natural balance. Overall, the positive effect on soil quality is a sum of many interactions that have the potential to completely restore degraded land, although it takes time and often requires additional supplementation of soil. The strategy should be tailored to use specific species to problematic pollutants to achieve the best results.

Introduction

Soil is a natural finite resource base which sustains life on earth. It is a three phase dynamic system that performs many functions and ecosystem services and highly heterogeneous. Soil biota is the biological universe which helps the soil in carrying out its functions. Problem soils can be defined as the soils on which most plants and crops cannot be grown economically and are not fertile or productive and there is the possibility of erosion hazard when cultivated (Huq and Shoaib, 2013). Types of Problem soil are acidic soil, alkaline soil, saline soil and heavy metal contaminated soil. Contamination of agricultural soils with trace metals present lethal consequences in terms of diverse ecological and environmental problems that entail entry of metal in food chain, soil deterioration, plant growth suppression, yield reduction and alteration in microbial community. Metal polluted soils have become a major concern for scientists around the globe.

Acidic Soil Reclamation

• Acid soil inhibits the nitrogen fixation by reducing the activity of *Azotobacter* and *Rhizobium*.

• Liming of acid soil increases the activity of bacteria & actinomycetes & lowers the fungal population in turn reduces the disease infection (Narendrula and Nkongolo, 2017).

• The increase in soil pH resulting from the application of lime provides a more favorable environment for soil microbial activity which increases the rate of release of plant nutrients, particularly nitrogen.

Alkaline Soil Reclamation

• Alkaline soil with high pH values and Na^+ content favor the growth of diazotrophic cyanobacteria with a consequent decrease in pH. Indeed, cyanobacteria can decrease soil pH from 9.2 to 7.5 by producing organic acids (Kapil *et al*., 2005).

• Cyanobacteria could be used to reclaim alkaline soils because they form a thick stratum on the surface of the soil during the rainy season and the winter months.

• The algal material incorporated in the soil conserves organic C, organic N, and organic P as well as moisture, and converts Na^+ clay to Ca^{2+} clay.

• Organic matter and N added by cyanobacteria bind the soil particles, and thus improve soil permeability and aeration.

• Sulphur oxidizing bacteria reclaim alkali soil.

Saline Soil Reclamation

• Nitrogen-fixing cyanobacteria can be used as biological input to improve soil texture, conserve moisture, scavenge the toxic sodium cation from the soil complex and improve the properties of soils.

• Certain cyanobacteria have been found not only to grow in saline ecosystems but also improve the physico-chemical properties of the soil by enriching them with carbon, nitrogen and available phosphorus.

• Flushing of field may not be effective for the reclamation of saline soils and the addition of cyanobacterium inoculum along with the addition of gypsum is required before irrigation to ameliorate saline soils (Singh and Dhar, 2010).

Heavy Metal Contaminated Soil Reclamation

Cyanobacteria could have a higher efficiency in the biosorption during its growth in polluted environment for the removal of heavy metals (Singh, 2020).

Conclusion

The use of microbial bioremediation in recovering polluted soils is not a new technology based on many review reports and studies on its efficiencies and on how to increase the effectiveness. The future studies should focus on how to increase the effectiveness of the bioremediation technology that should further reduce environmental stress on the terrestrial and aquatic ecosystems. Investigations on bioremediation of environmental toxicants are entering in a new era with the application of genetically engineered bacteria. However, majority of the studies related to bioremediation of heavy metals have been conducted under the laboratory conditions. It is too difficult to study the decontamination of the polluted sites in natural environments because of the implication of various factors in detoxification process. Therefore, future researches would be more focused on.

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